RFI Forum

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Definition - interference:

Interference should be defined without emotion. It is the unwanted interaction between two systems. Any other definition carries an implication of fault or blame.

Ed's Rules!

RFI problems involve a combination of personal and technical issues.

Knowing all of the technical solutions won't do you any good if your neighbor won't allow you into the house to apply them!

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Your RFI problem - survey:

- Interference involving station transmitter
- Interference involving station receiver (includes power-line, electrical noise, etc....)
- Interference problem with own consumer equipment
- Total

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Most cases of interference are not reported!

- FCC
- Electronic Industries Association
- National Cable Telecasters Association
- ARRL
- Manufacturers do not feel there is an RFI problem!

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Personal diplomacy:

- RFI problems involve people
- Don’t start off on wrong foot
- The first knock
- Each party feels the other is the “cause” of the problem
- The other person involved is your neighbor
- You can only fix it where it is broken
- Consumer Pamphlet

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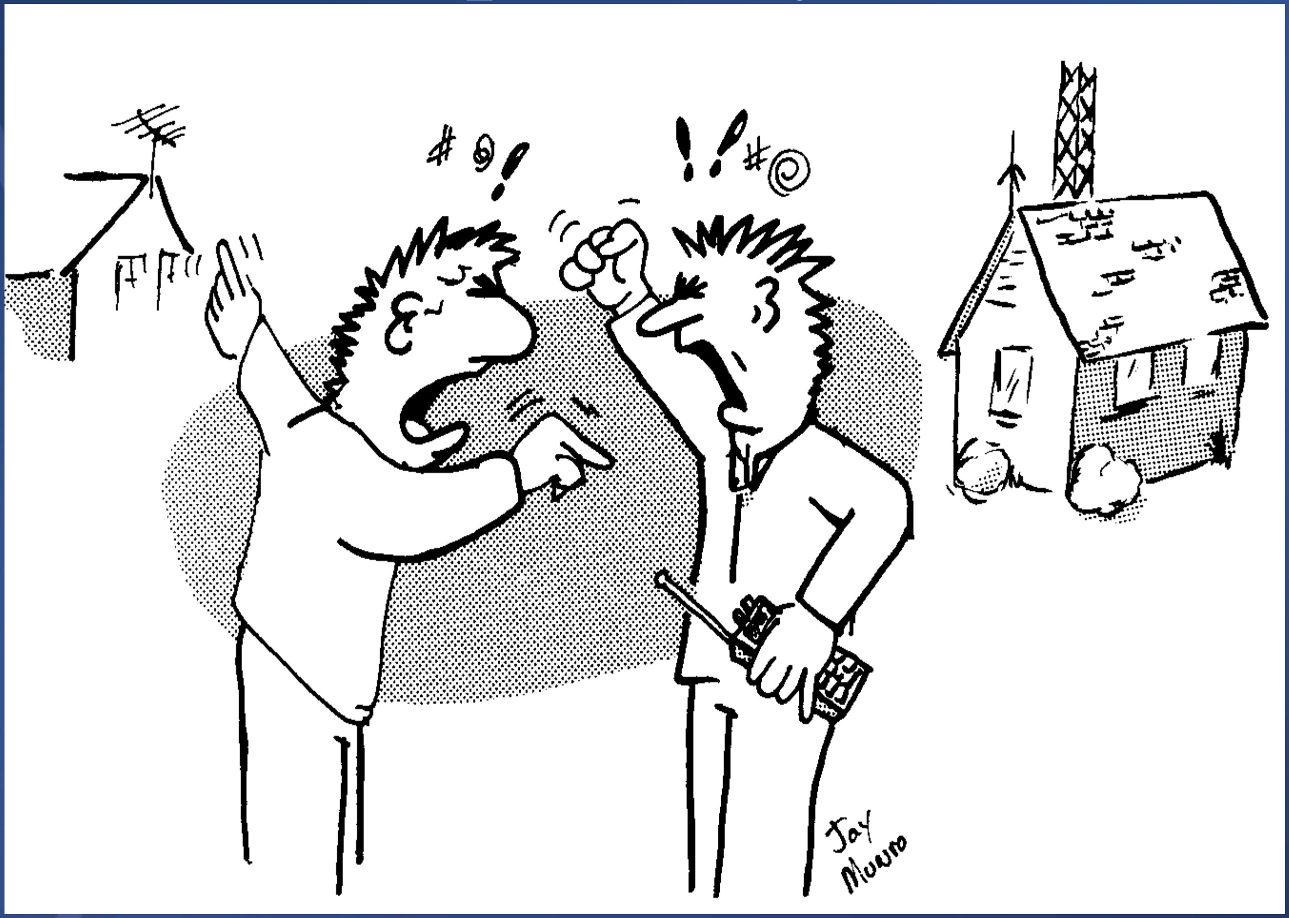
There are alternatives to personal diplomacy



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Personal Diplomacy

"Here's a choke that will fix the whole problem!"

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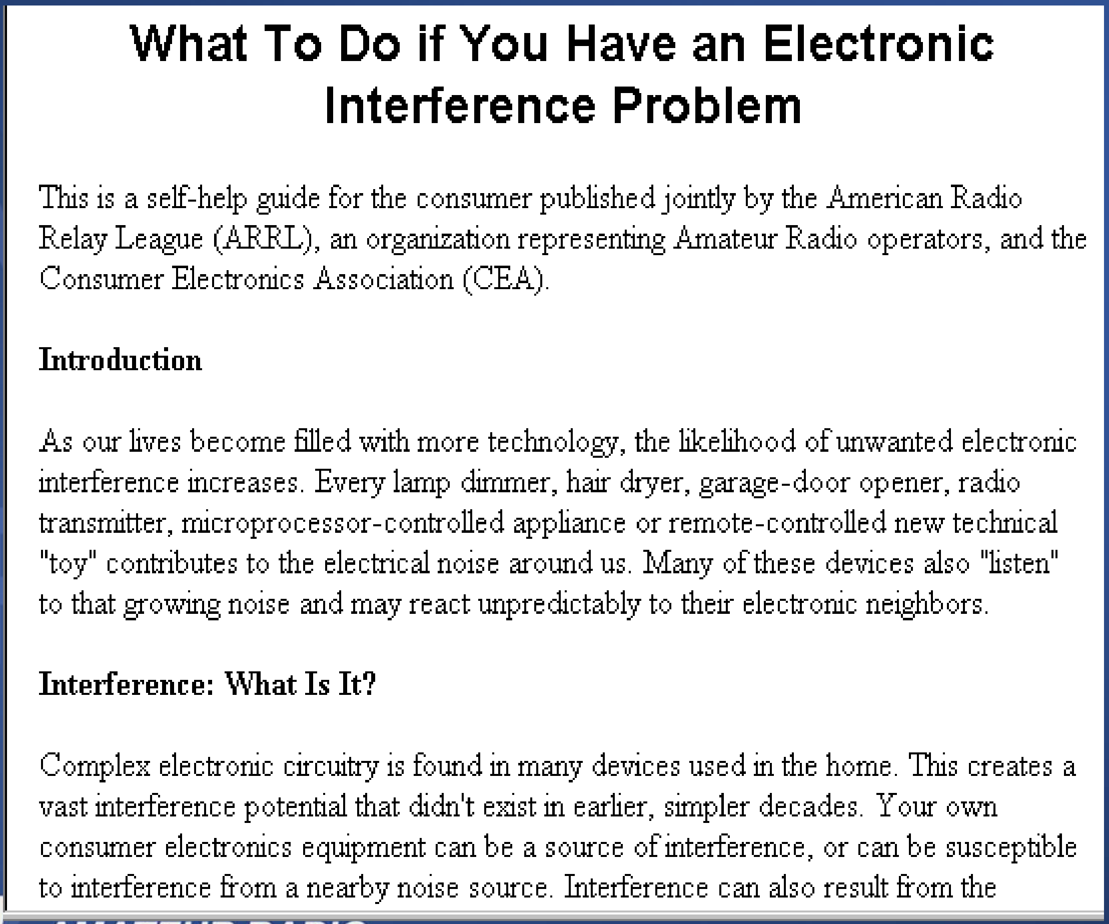
Pamphlet for Your Neighbor!



What To Do if You Have an Electronic Interference Problem

This is a self-help guide for the consumer published jointly by the American Radio Relay League (ARRL), an organization representing Amateur Radio operators, and the Consumer Electronics Association (CEA).

Introduction

As our lives become filled with more technology, the likelihood of unwanted electronic interference increases. Every lamp dimmer, hair dryer, garage-door opener, radio transmitter, microprocessor-controlled appliance or remote-controlled new technical "toy" contributes to the electrical noise around us. Many of these devices also "listen" to that growing noise and may react unpredictably to their electronic neighbors.

Interference: What Is It?

Complex electronic circuitry is found in many devices used in the home. This creates a vast interference potential that didn't exist in earlier, simpler decades. Your own consumer electronics equipment can be a source of interference, or can be susceptible to interference from a nearby noise source. Interference can also result from the

No-fault RFI!

- All people involved may have responsiblities
- To find a solution, everyone must address their responsibilities fairly
- Offer neighbor consumer pamphlet
- Explain the interference can come from transmitter or consumer equipment
- If transmitter, you will fix your station
- If consumer equipment, you will help find a solution

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A radio operator is a locator of solutions, not a provider of solutions!

- Must cure transmitter
- Should NOT cure consumer equipment
- Liability -- TV tale
- Exceptions

Responsibilities of the radio operator:

- Proper operation of the station
- Cooperate to troubleshoot
- Cure problems at station
- Help locate solutions
- Help explain the issues

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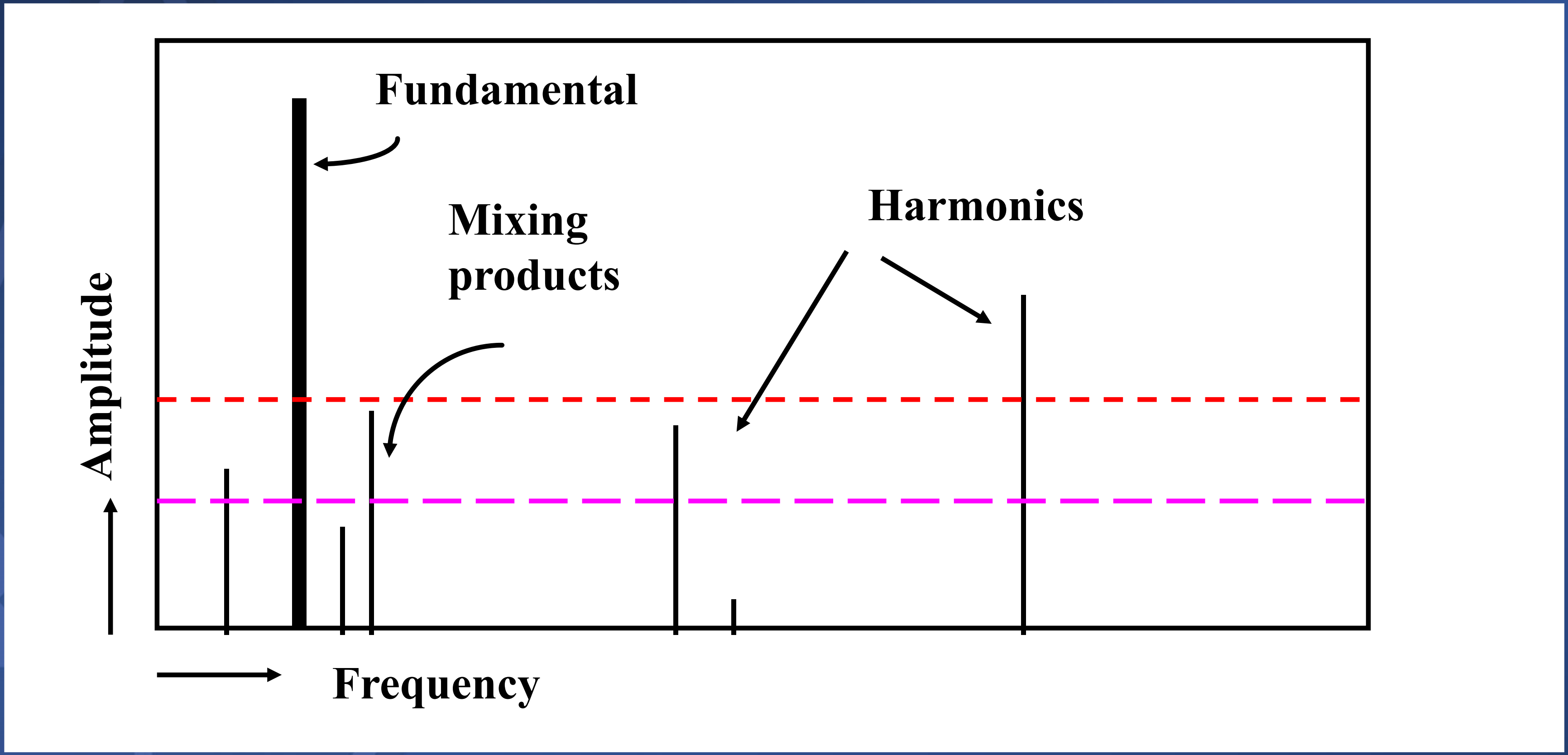
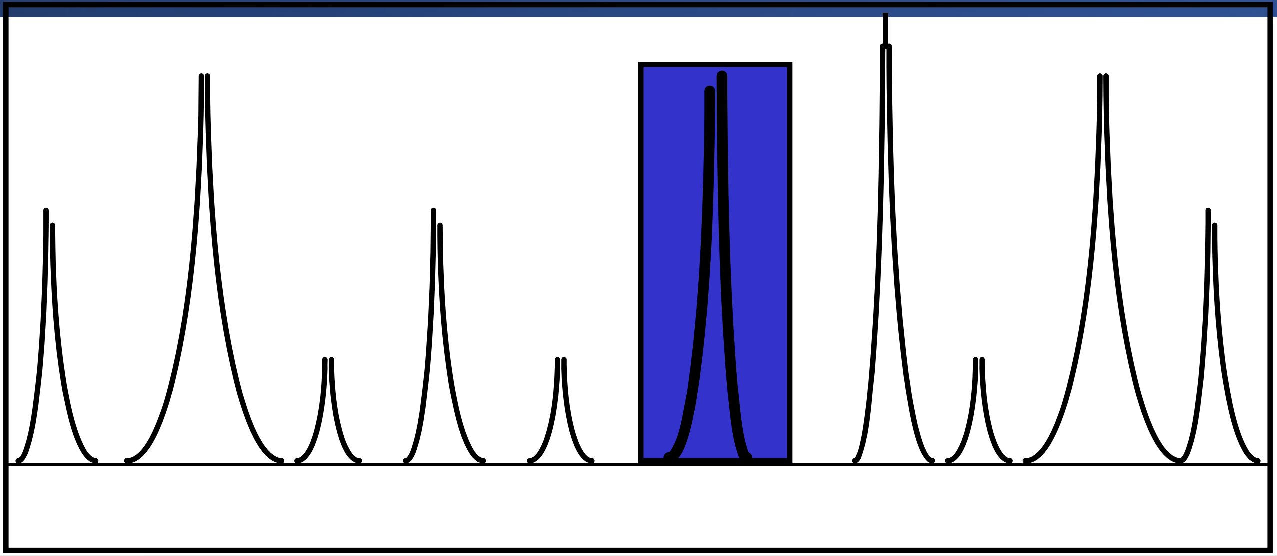
Spurious emission:



All transmitters emit some signals other than the fundamental.

Fundamental overload:



Consumer devices should be able to select only the signals they want to receive, while rejecting all others. Some of these other signals may be stronger than the desired signal.

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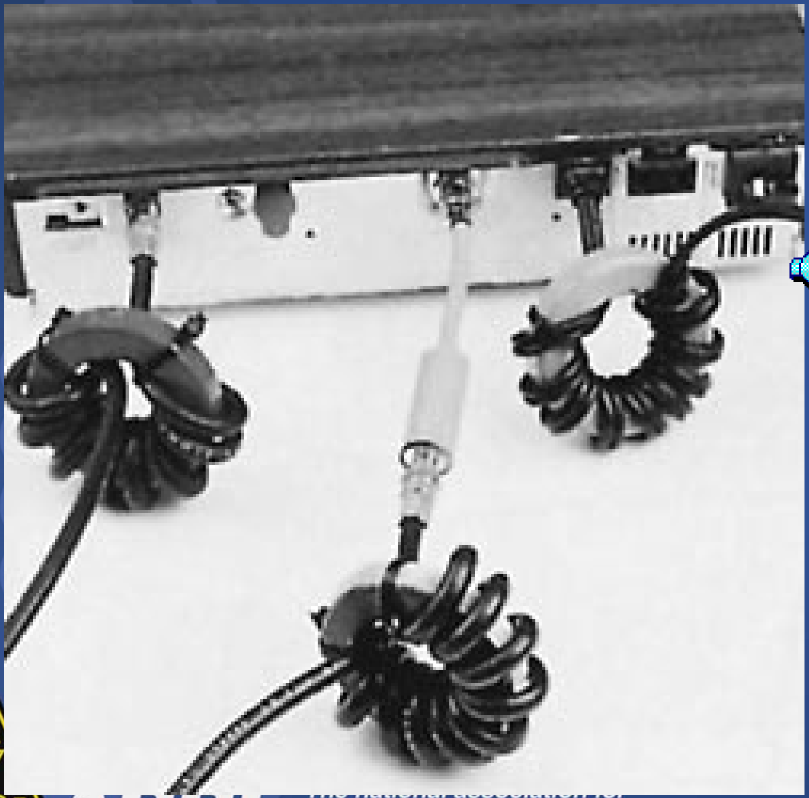
“Stock” cures for RFI:

- Shielding
- Filters
- Ferrites and chokes
- Ground

Filter types:

- Low-pass
- High-pass
- Common-mode
- AC-line

Making A Common Mode Choke



- Wrap the cable or wires (as a pair) around the toroid.
- Typically use 8 to 12 turns.
- Place choke as close as practical to offending device.
- Some cases may require more than one choke.

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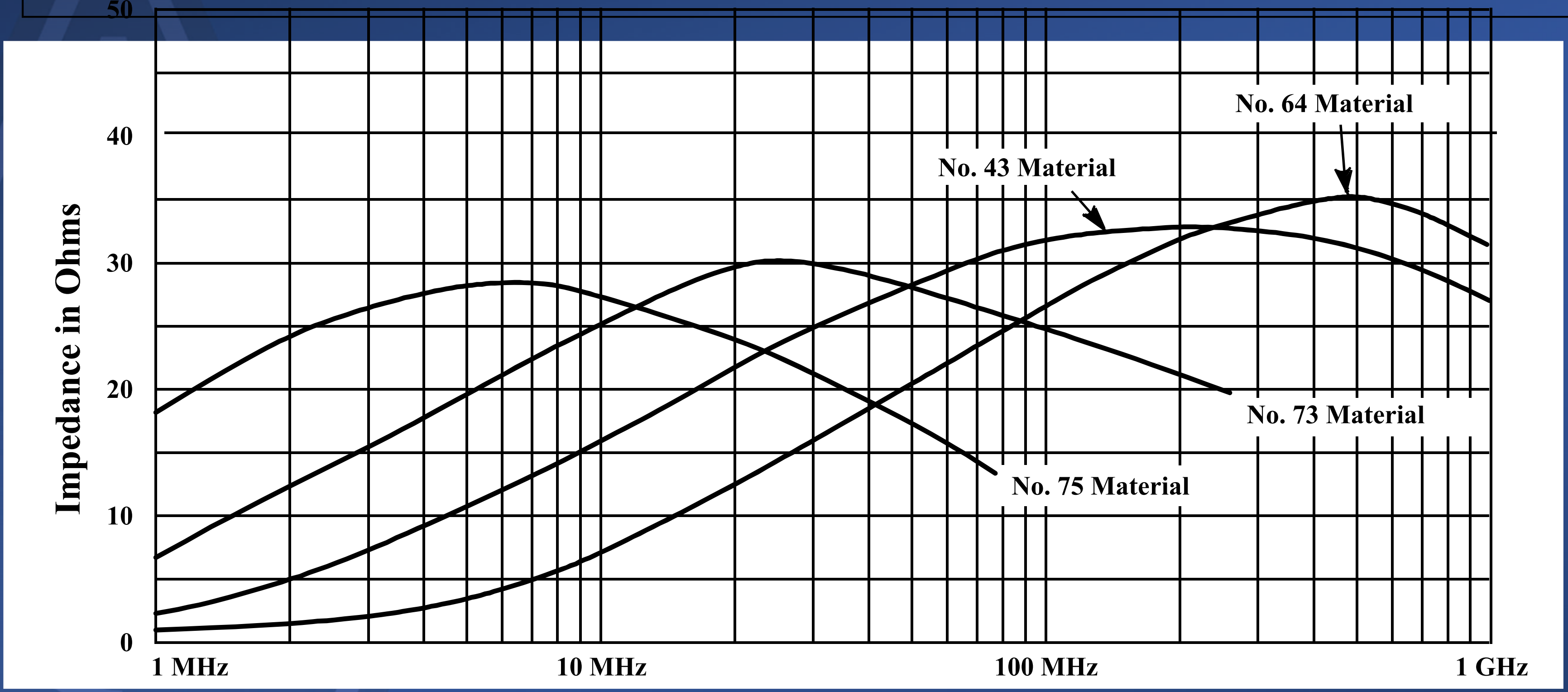
Ferrite material vs frequency graph:

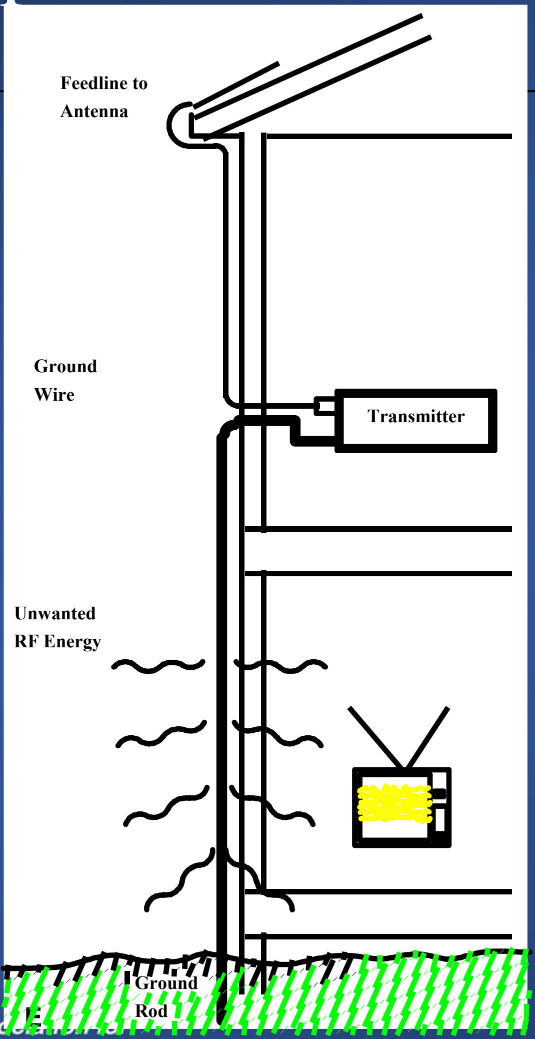


This chart is the impedance of a single bead of ferrite material.

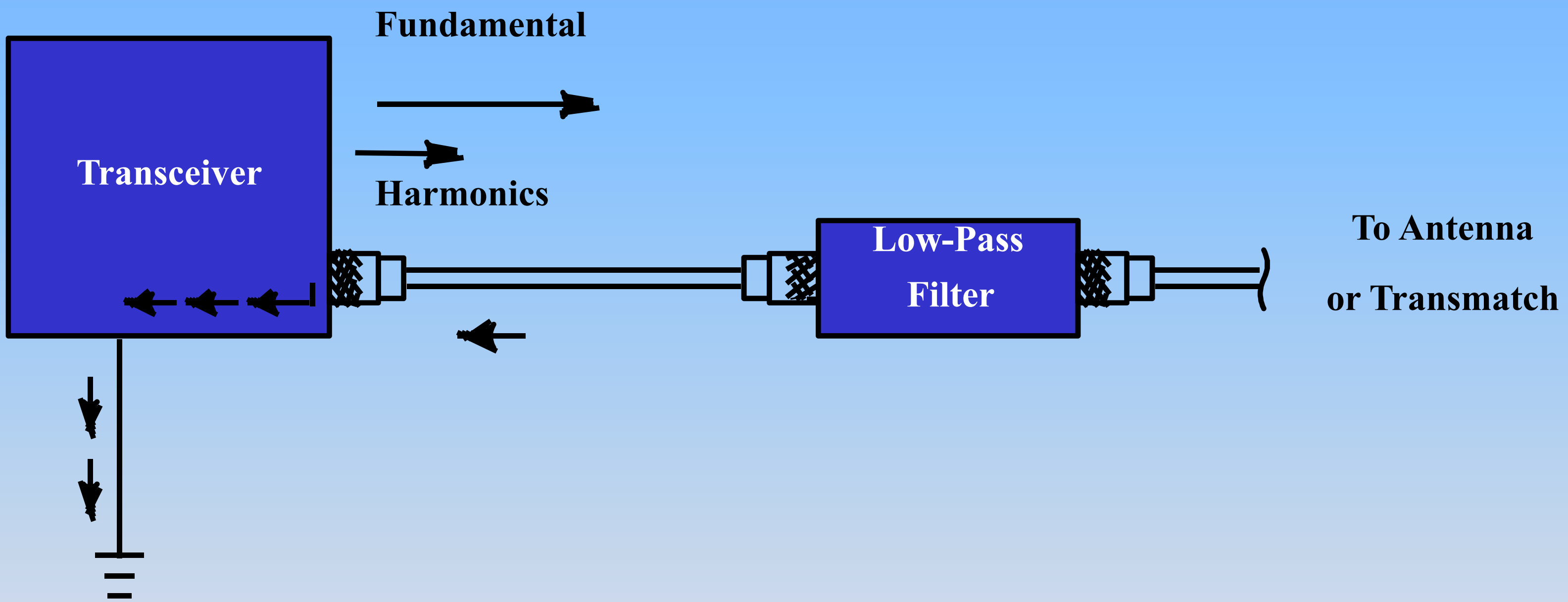
Ground:

- Not a mysterious sink into which signals disappear
- Not cure-all for EMI problems
- Circuit concept
- Common reference point between two circuits
- Conductor, infinite plane
- All conductors have impedance
- All conductors have physical size
- No such thing as an RF ground

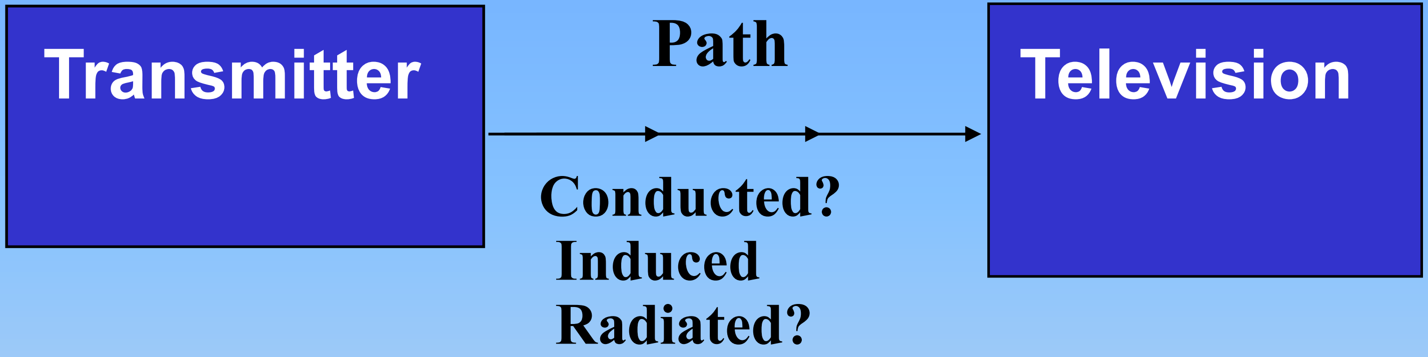
Grounding problems - Ground Antenna:



Grounding does have uses:



Troubleshooting:



Transmitter

Path

Television

Conducted?
Induced
Radiated?

Cause?

Harmonics?
Fundamental overload?
External rectification?

Cure?

High-pass filter?
Low-pass filter?
Ferrites?
Shielding?
Grounding?

Three-step process:

- Identify the problem
- Diagnose the problem
- Determine what will fix the problem

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Troubleshooting tips:

- Ensure that your own station is clean!
- Understand what kind of problems can be (and can NOT be) caused by transmitter defects
- It ain’t me!
- Use good installation techniques
- Most EMC problems have multiple causes
- Simplify the problem
- Try one (and ONLY one) thing at a time
- Look for the obvious; look for the unexpected

Your station:

- Start with your station
- It is NOT the most likely source of interference, but it IS the part under your direct control
- Keep your station “clean”

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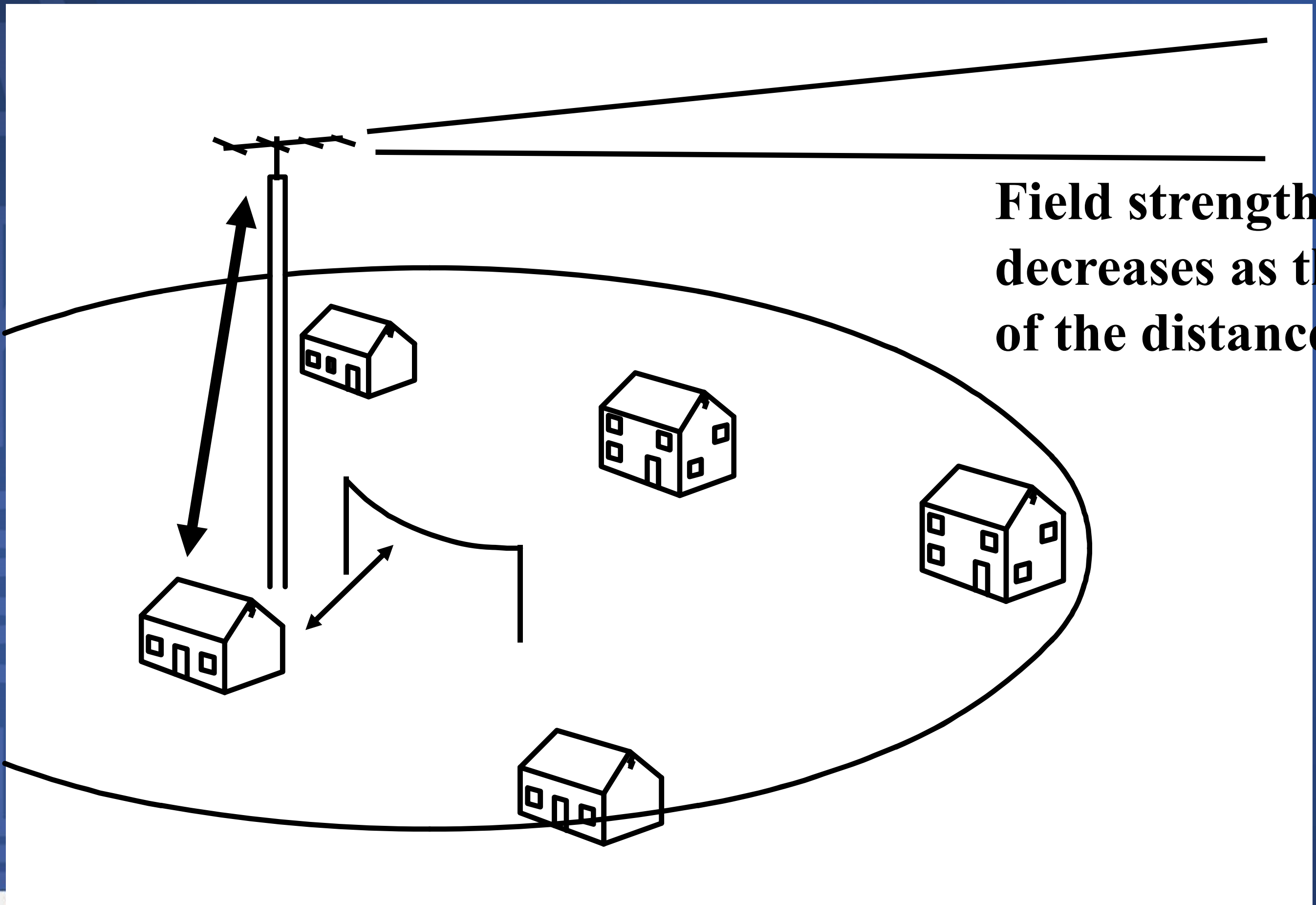
Your station:
What the FCC likes to see:

- Install a low-pass filter, whether you need one or not
- Install a good ground, whether you need one or not
- Keep a working TV and telephone in your shack

Antenna height and distance:



Field strength decreases as the square of the distance.

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Consumer Devices

- Consumer devices are a common RFI problem – both to and from amateur equipment.
- Most consumer devices fall under FCC Part 15 rules.
- Part 15 devices must not cause harmful interference to a licensed radio service.
- Under FCC rules, the operator of the offending device is responsible for correcting the problem.
- If you own the offending device, you are responsible for fixing it.

Electrical noise - Two types of electrical problems:

- Electrical noise - usually differential mode
- RF picked up on power lines - usually common mode
- These are two distinct phenomenon

Power Line – ARRL/FCC

- ARRL has a cooperative program with the FCC to resolve power-line noise
- First step is for the ham to work with the power company
- ARRL then sends a letter, under the cooperative agreement
- If no response, case is forwarded to the FCC
- Follow-up letter
- Refer to FCC field offices
- Months, not days
- Laura (the new Riley)

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Power lines:

- Leave the problem to the power company
- Common problems - loose ties, noisy insulators
- Any part is suspect
- DO NOT BANG ON POLES!

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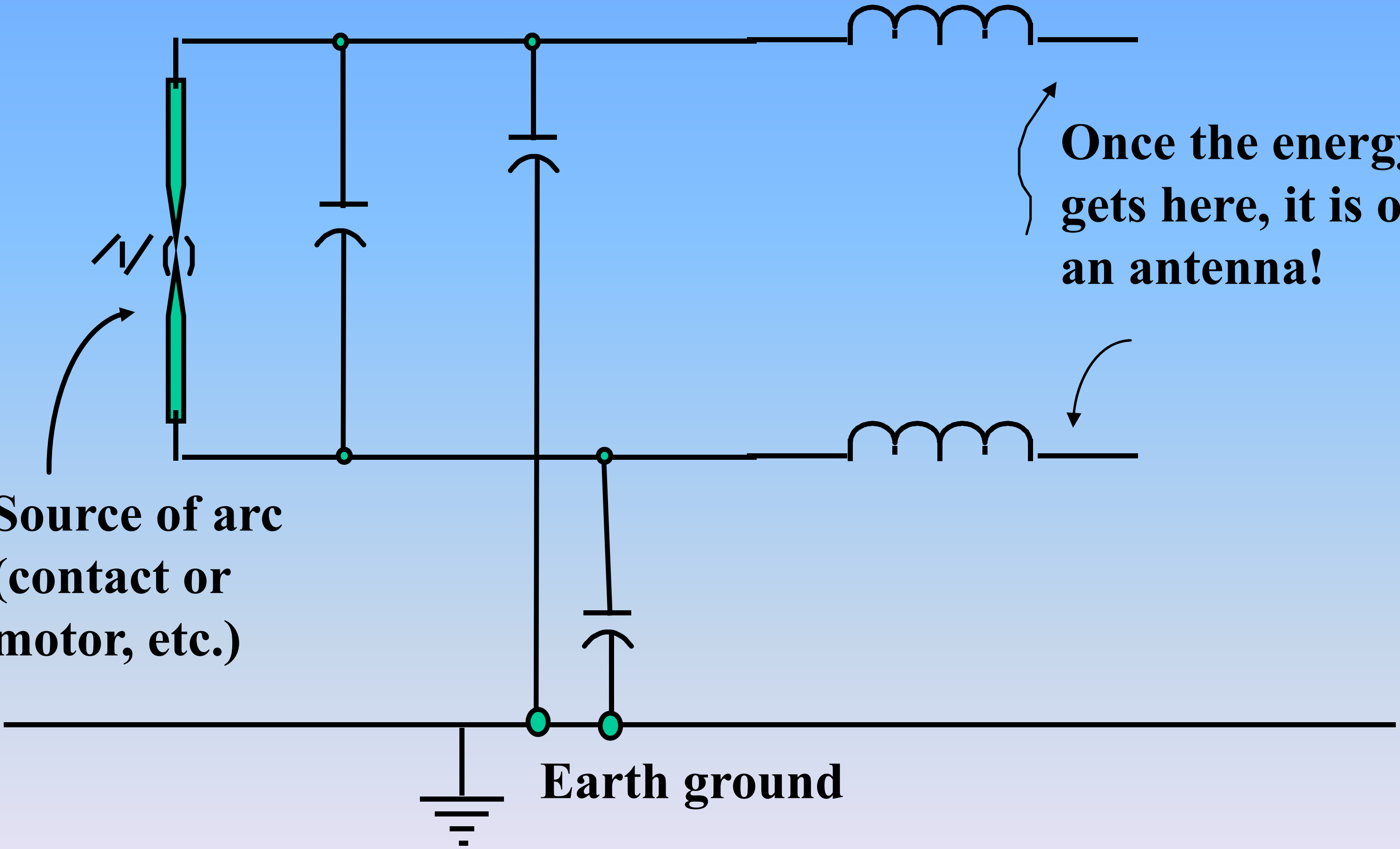
Electrical noise suppression:

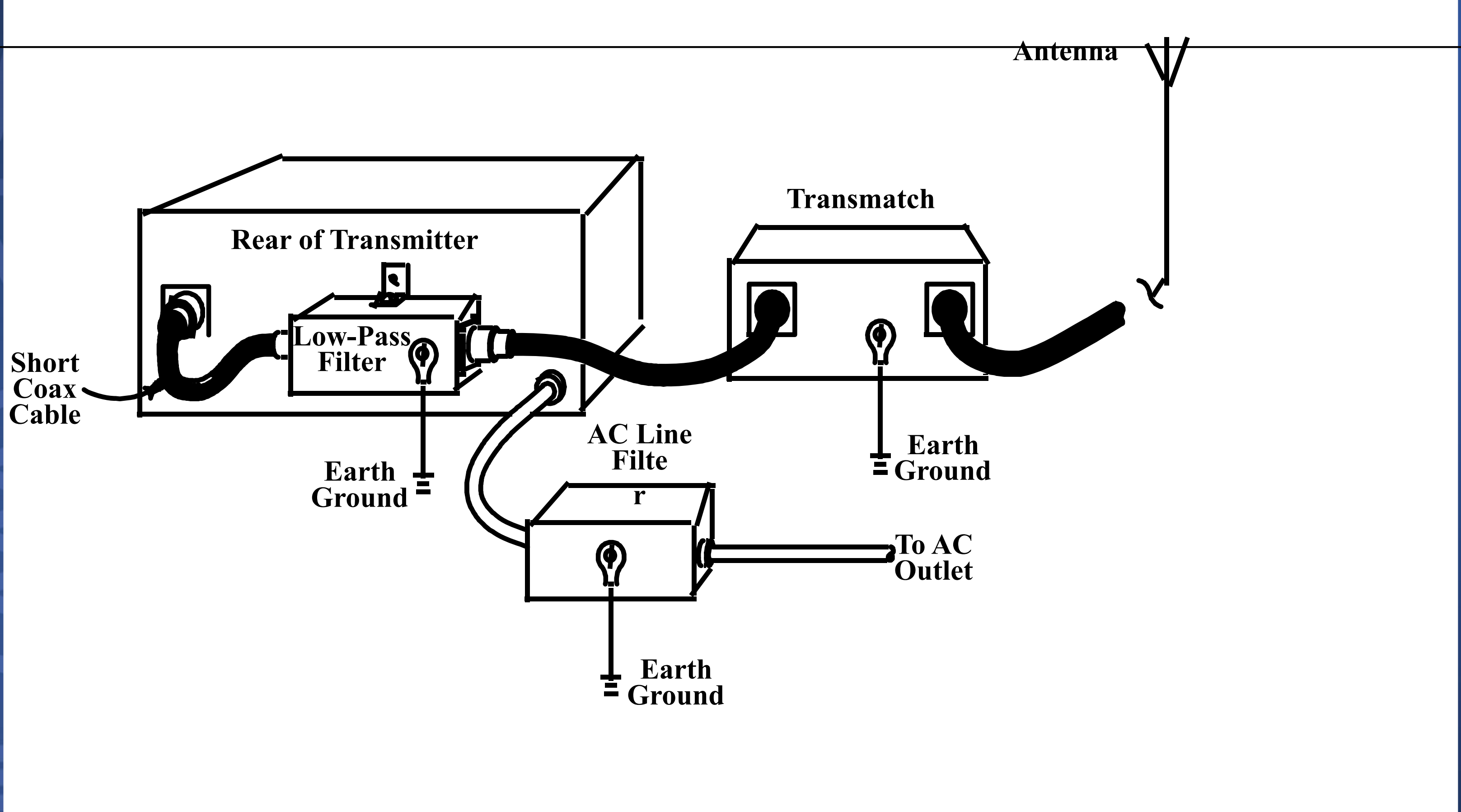


Once the energy gets here, it is on an antenna!

Source of arc (contact or motor, etc.)

Earth ground

Proper place to install transmitter filters:



TVs - find the root cause:

- Remember the rules
- If transmitter, can't fix the TV
- If electrical noise source, can't fix the TV
- Be SURE it is the TV

Fringe reception not protected by the FCC:

- FCC doesn’t expect TV signals to propagate forever
- Outside the Grade B contour, TV is not a “radio service”
- Any help is voluntary
- See FCC *Interference Handbook*

Ed’s Rules:

Courtesy of Dave Heller, K3TX

- If an amateur can demonstrate that an antenna-connected TV close to the transmitter and its antenna is not subject to interference, the transmitter is “clean.”
- If a transmitter is interfering with a known-immune TV, it MUST be fixed before anything is done with other TVs.

“Fundamental” causes of TVI:

- Fundamental overload
- Blocking
- Audio rectification
- Video rectification
- Often caused by common-mode signal

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“Non-fundamental” causes of TVI:

- Harmonics from transmitter
- Harmonics from TV
- Harmonics from external sources

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TVI tip for cable TV:

- Disconnect antenna
- Touch antenna grounds together
- Try common-mode choke and filter on AC line cord

TVI tip:

- If interference is to all channels, it is usually fundamental overload
- If interference is only to channels harmonically related to the carrier (see the chart), it is harmonics.
- The harmonics may be coming from the transmitter, the TV or an external non-linear system.

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CATV - a blessing and a curse!

- The blessing:
  - Sealed system
  - Delivers strong TV signal
- The curse:
  - Uses frequencies allocated to over-the-air services
  - Leakage out (egress)
  - Leakage in (ingress)

The fallacy - all CATVI is the responsibility of the cable operator!

- Operator responsibilities
- 76.611 (leakage)
- 76.605 (picture quality)
- Operator non-responsibilities
- Cable-ready equipment
- Try set-top converter

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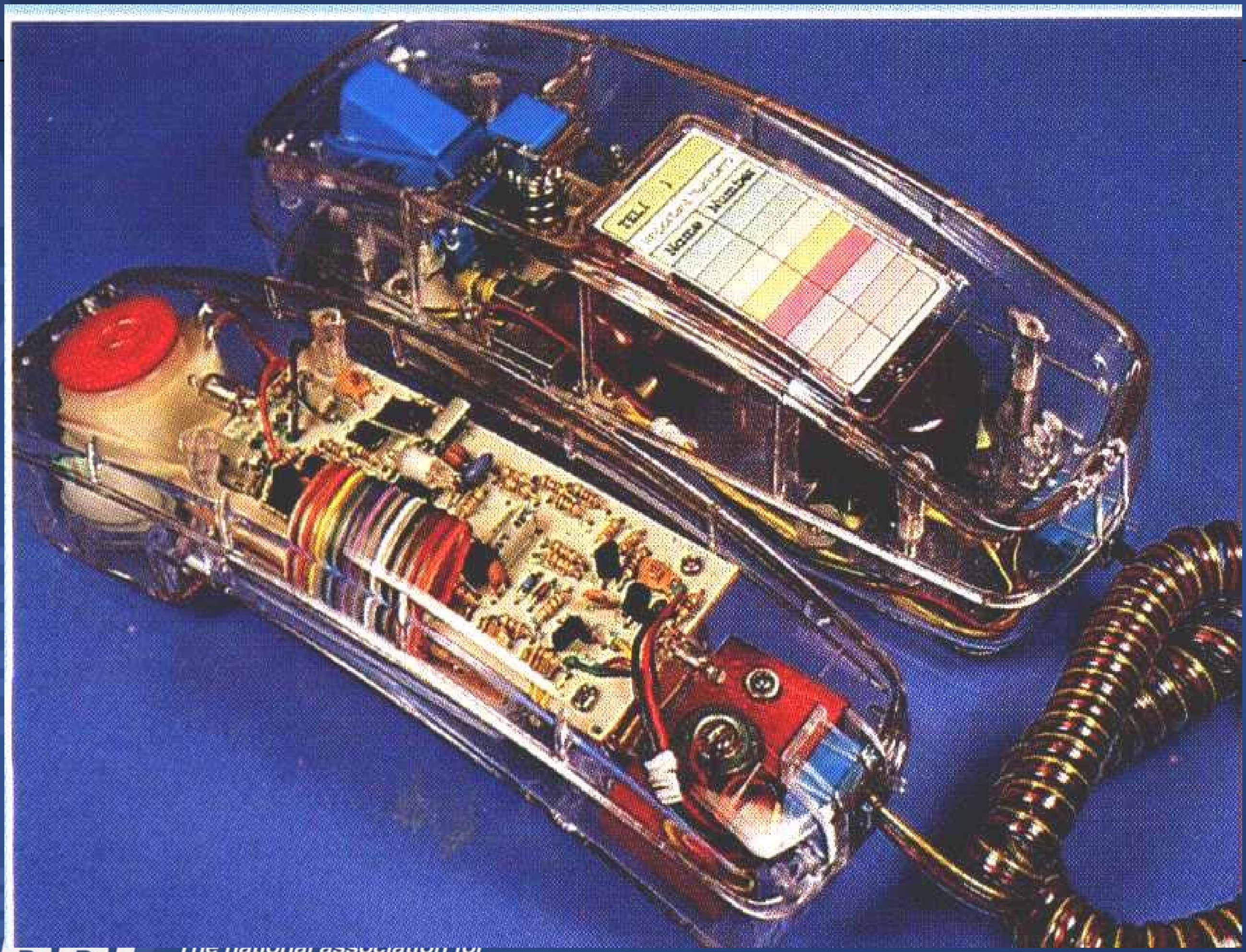
Photo - Clear phone



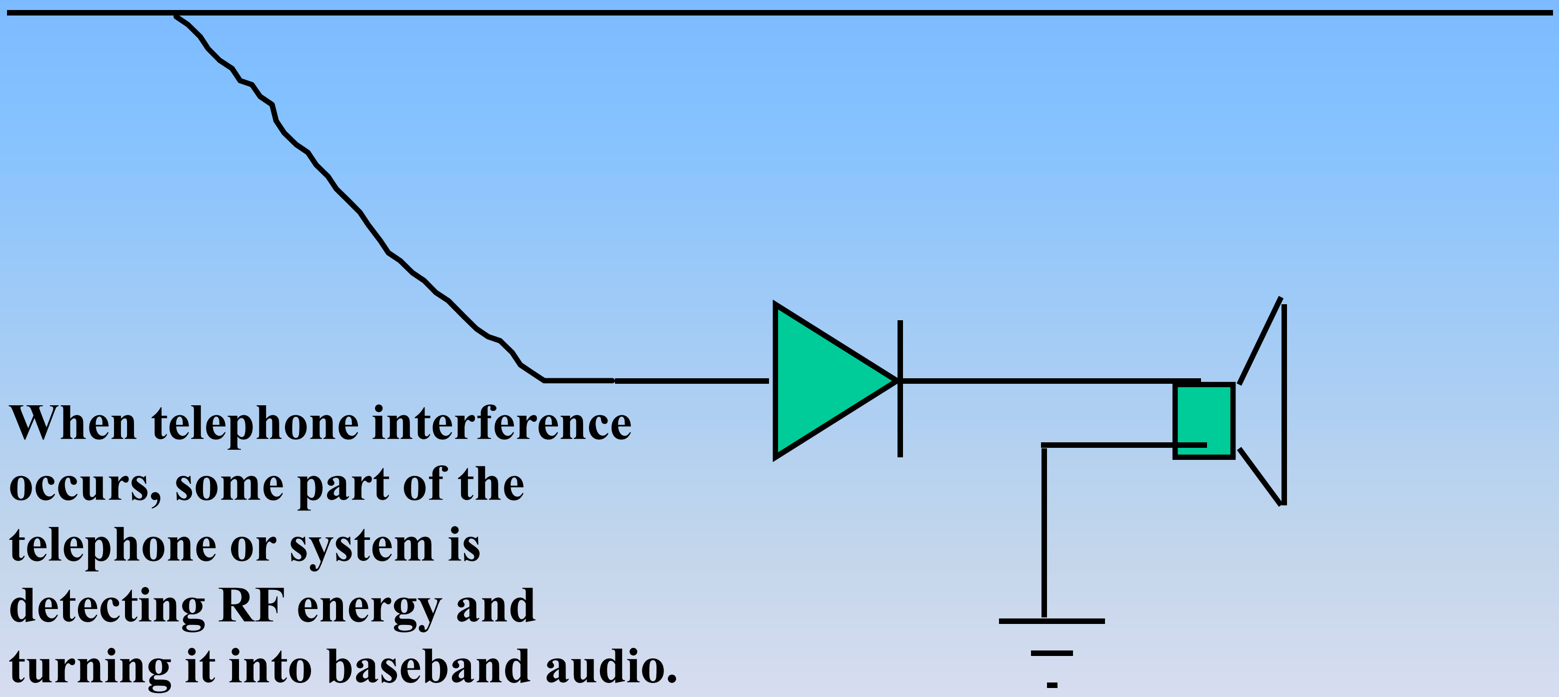
From the FCC *Interference Handbook* :

Part II

INTERFERENCE TO OTHER EQUIPMENT

Telephones, stereos, computers, electronic organs and home intercom systems can receive interference from nearby radio transmitters. When this happens, the device functions improperly as a radio receiver. Proper shielding or filtering can eliminate such interference.

The diode detector:



When telephone interference occurs, some part of the telephone or system is detecting RF energy and turning it into baseband audio.

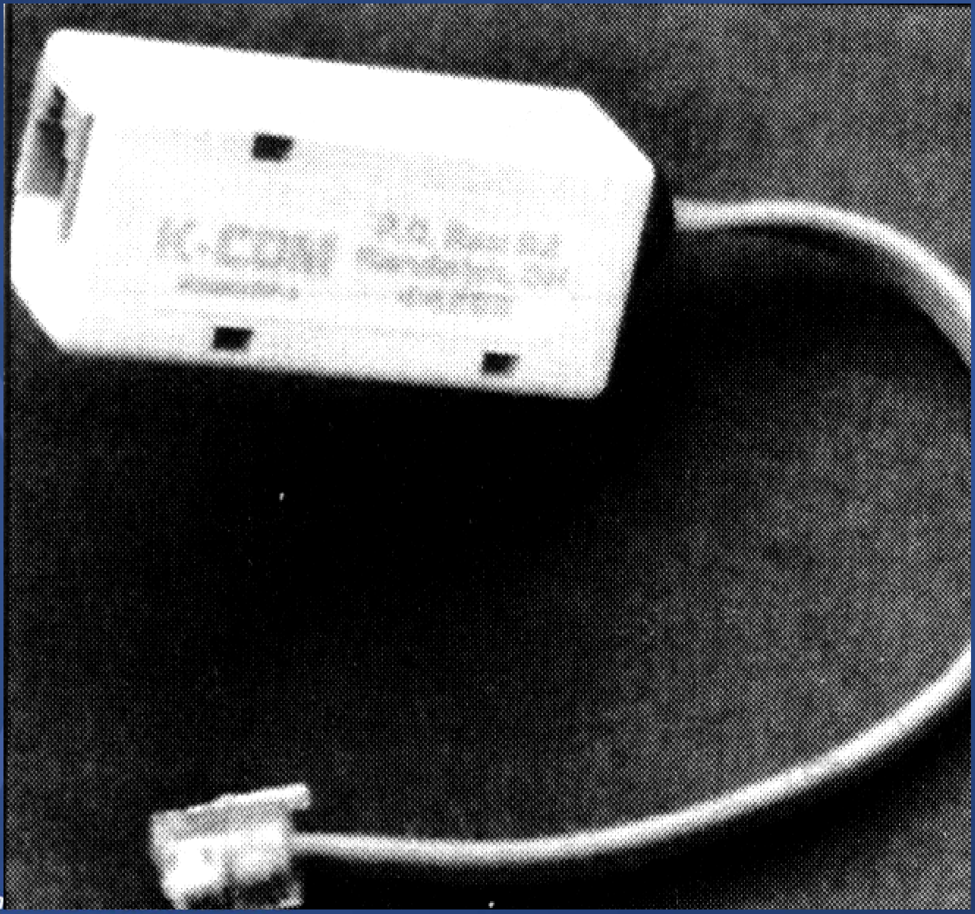
Location of the diode:

- Telephone
- Auxiliary equipment
- Telephone wiring (corrosion)
- Lightning arrestor
- Telephone company equipment
- Once detected and turned into audio, cannot be filtered

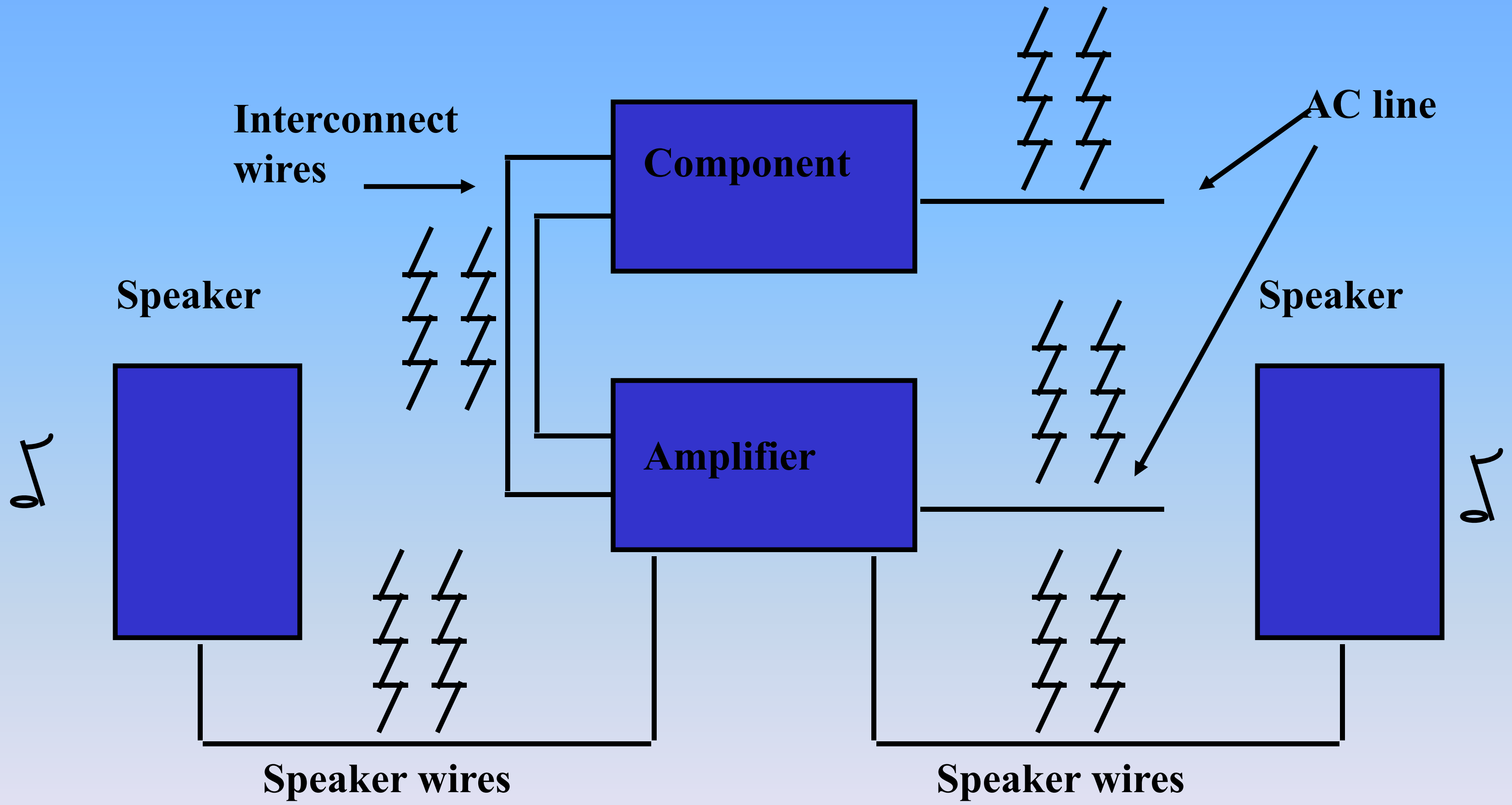
Telephone interference cures:

- Keep own house RFI-free
- Have RFI-proof telephone
- Simplify the problem (ask me to tell the tale!)
- Inspect telephone wiring, lightning arrestor
- Try filters
- Break up wiring resonances
- Ground unused pairs
- Connect pairs together
- Some telephones unfixable

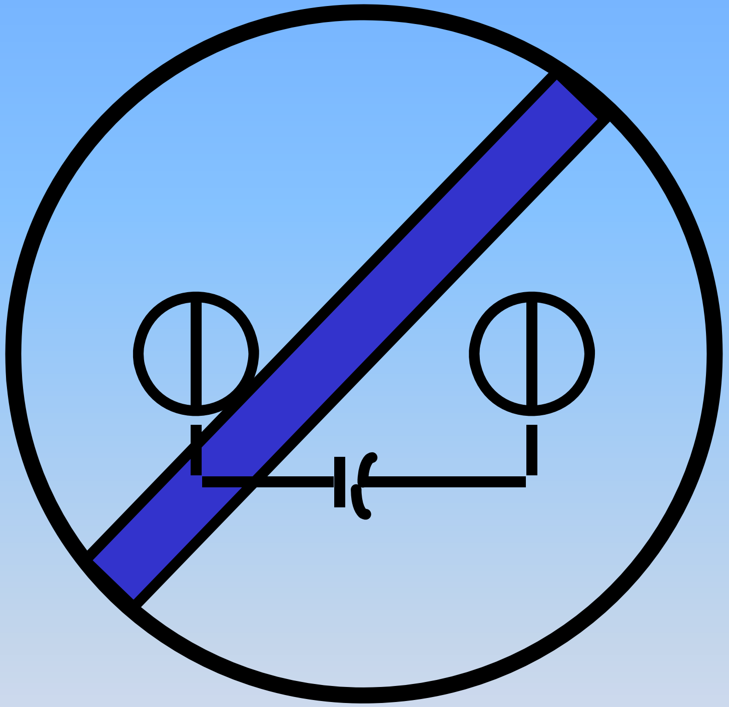
Typical telephone filter



Typical stereo system:



Don’t do it!



Computer cures:

- Use ONLY Class B devices
- Computers are not good antennas
- Birdies, switch-mode supplies, video monitors
- To troubleshoot, simplify!
- Ferrites to suppress RF
- Use shielded cables
- Internal “pigtails”
- Shielding, shielding sprays

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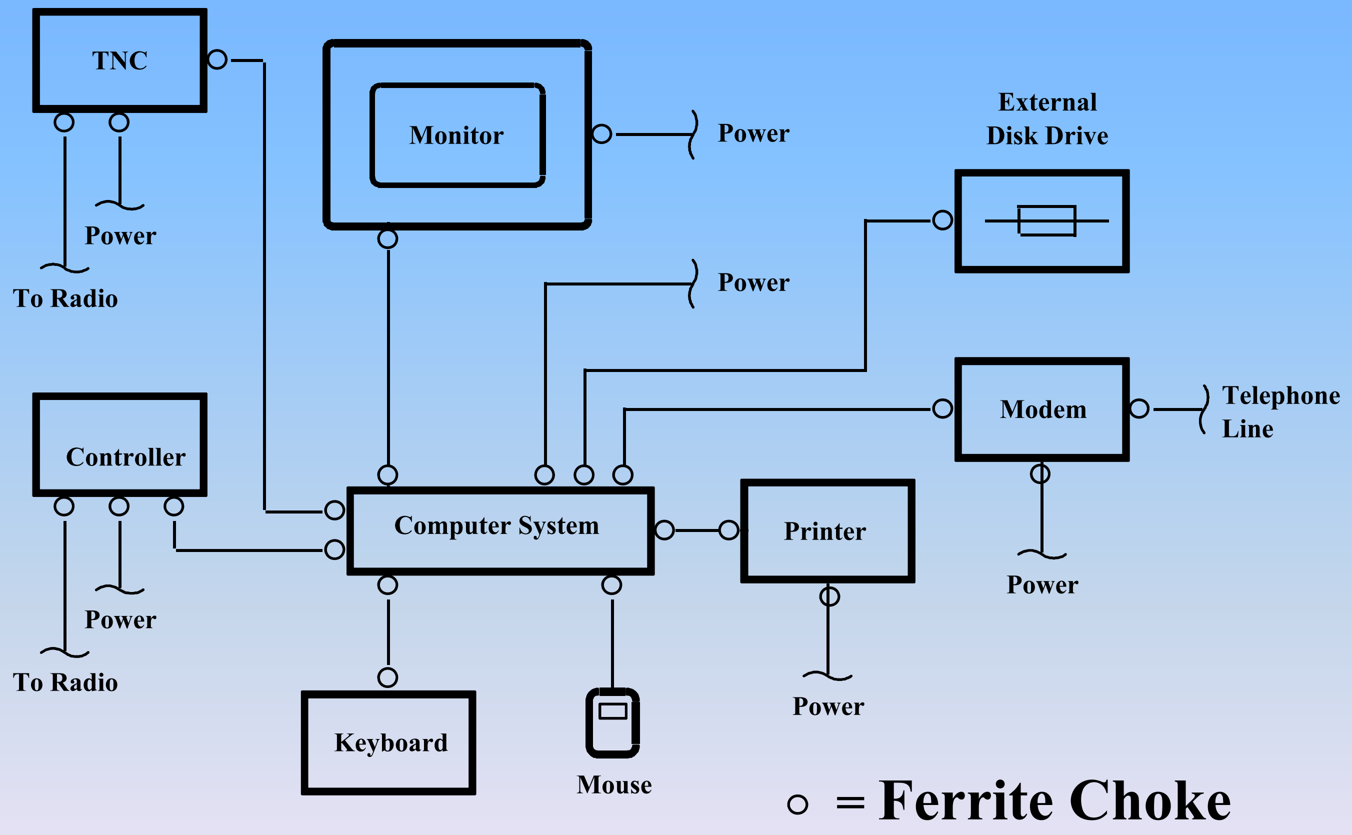
Ferrites on computers - to cure noise to or from computer:



○ = **Ferrite Choke**

Auto EMC is problem for the auto manufacturer:

- Easiest to cure at design
- Critical safety issues
- Modern cars with computers
- Auto may be under warranty
- Refer to September 1994 QST article

Installation guidelines:

- Run wires directly to battery
- Use chassis-mounted antenna
- Keep low SWR
- Keep wiring and antenna away from sensitive components
- Manufacturer best source of information

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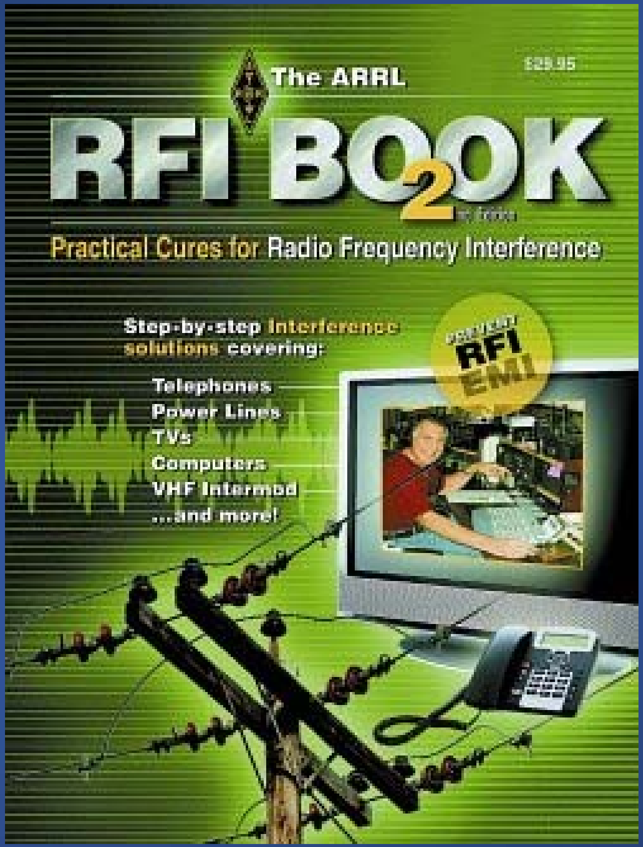
And, Of Course…



Q&A

a.k.a. Stump the Speakers

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MORE INFORMATION

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